deep. Probably a full half mile behind the first wave something similar to a tide rip appeared, waves 3 to 4 feet high probably not over 20 feet from crest to crest racing up the river. They would have made very rough going for a small boat.

As contrasted with the bore we saw it is said that the first wave is 10 feet high at times. In September, 1922, a small steamer was wrecked by the bore and succeeding waves, with a loss of 130 lives. That is the sort of bore we did not see.

Because of the need of getting back to Calexico that night we did not wait to see the high tide.

Returning from Calexico to Yuma the next day the two other Yuma members of the party and I had opportunity to see the effect of the worst windstorm in years on the sand hills. Where the road crosses this "Sahara of America" the sand-hill area is about 5 miles wide. An eight foot plank road has been built through this section which would otherwise be impassable and an average of about 200 cars pass over it daily. The shifting sands have always been a problem and men with teams and scrapers are maintained at all times to keep the road clear. This storm had been too much for them. Tongues of sand crossed the road in perhaps a hundred places. Where they were not over a foot or 18 inches deep the car took them on the rush but over the most exposed portion of the road the sand drifts were 4 or 5 feet deep. Some 60 cars were tied up when we arrived, some of them had been there 24 hours and our stock of provisions left from trip was quickly disposed of. To the east it was 10 miles to food and water, to the west 5 miles to the headquarters of the road workers. The wind was blowing a gale and the sand was going with it. I have long wanted to watch a storm in the sand hills. This opportunity was ideal save for the fact that for the next six hours we were constantly busy helping others and being helped. In that time we moved forward nearly half a mile, past the worst obstructions and were at last free to go. The impression of a storm in the sand hills is not very different from that of a snowstorm; there is the unending stretch of light grey sand, huge drifts and the air filled with flying particles. I hope to spend a day there a little later in the season with anemometer and single register getting an idea of the wind movement and progress of the dunes. The problem of a road has not been satisfactorily solved and the road department would welcome any definite information. The all-American canal to the Imperial Valley is to go through the sand hills also and the Reclamation Service is anxious to secure data on sand movement as a problem for the canal.

Because of the high wind and sand haze pictures taken on the trip were not entirely satisfactory. I am inclosing a few of the best secured.

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LEE ON EVAPORATION LOSS FROM WATER SURFACES: MOIST SOILS, WITH SPECIAL REFERENCE TO CONDITIONS IN WESTERN AMERICA

By A. J. HENRY, Meteorologist

[Weather Bureau, Washington, March, 1924]

[Abstract]

The author writes from the standpoint of the practical hydrologist rather than from that of the physicist. After directing attention to the increasing needs for more accurate measures of evaporation he stresses the necessity for the adoption of standard methods of observation, a subject to which further reference will be made later.

Attention is directed to the common failure of many experimenters to closely simulate in the exposure of the experimental pans the natural conditions in the lake or other body of water whose evaporation is sought. Thus floating pans submerged in a large body of water approach rather closely to the actual temperature of the lake or reservoir. In his experience the temperature of the water in floating pans made of light colored metal and kept clean does not vary more than 1° F. or 1.5° F. from that of the surrounding water.

In the matter of vapor pressure, according to the author, there is even greater departure from natural conditions. Too little attention is given to securing a free movement of the air across the pan.

The size of the pan, too, is often given too little consideration.

Concerning lack of standardization of methods of measuring evaporation from water surfaces a list of methods in general use is presented, as in the table below; the table contains in the column next to the last on the right values of the relations of the various rates to that from a 12-foot land pan set in the ground. The data are quoted from Sleight.[1]

TABLE 1.—*Various devices used for measuring evaporation from water surface*

Type	Used by—	Size	Surroundings	Relation to evaporation pan set in ground, as observed by Sleight	
				Mean ratio	Mean ratio
				Per cent	*Per cent*
Piche evaporimenter.	U. S. W. B.		In instrument shelter.		−28.5 to +42.6.
Air pan	U. S. W. B. at Reno and Salton Sea.	Various	Elevated above land or water surface.		
Land pan	U. S. W. B. standard.	4 feet diameter, 10 inches deep.	Above ground.	151.8	−14 to +19.
Land pan or tank.	U. S. D. A. and State experiment stations.	1 foot diameter, 3 feet deep.	Set in ground 2.7 feet.	155.5	−23 to +24.
	do	2 feet diameter, 3 feet deep.	do	129.9	−18 to +17.
	do	3.39 feet diameter, 3 feet deep.	do	120.2	−15 to +19.
	do	6 feet diameter, 3 feet deep.	do	110.2	−11 to +10.
	do	9 feet diameter, 3 feet deep.	do	101.1	−13 to +9.
Floating pan.	U. S. W. B. at Salton Sea.	Various	On raft		
	U. S. G. S. standard.	3 by 3 feet, 1.5 feet deep.	Submerged 1.25 feet.	[1] 108.1	−10 to +11.

[1] Applying correction determined by Sleight as 1.049, to reduce to value comparable with that from circular pans, this is 103 per cent.

A lake or reservoir, considered as a whole, has not as great an opportunity for dissipating its vapor as a pan, since escape is practically limited to the vertical direction. The perimeter of a small pan, however, is relatively large compared to its area since it varies directly with the diameter, while the area varies with the square. The vapor dissipating horizontally from a small pan thus bears an appreciable ratio to the total, while from a large body of water it is practically negligible. The ratio of the rate of wind movement to the distance across a body of water is also an important consideration.

The author holds that temperature, relative humidity, and wind movement are the controlling factors in evaporation from water surfaces.

[1] Sleight, R. B., Evaporation from the surfaces of water and river-bed materials U. S. Dept. Agri., Jour. Agri. Research, Vol. X, No. 5, pp. 209-262.

Quoting again from Sleight it is stated, all other factors being similar, that for each Fahrenheit degree of temperature within the natural range of large bodies of water there occurs a change in the rate of evaporation averaging 6 per cent. The effect of pressure is probably negligible.

The effect of varying specific gravity upon the evaporation rate is presented in some detail, the author quoting from his own studies in the matter as follows:

In order to work out problems arising in the writer's practice, he found it necessary a number of years ago, to undertake an experimental study of the subject. The details and results of this study are herewith presented for the first time. The general program was to evaporate, under exactly similar conditions except as to specific gravity, two samples of water, one distilled and the other a brine with specific gravity 1.11 taken from Owens Lake, Calif., a mineralized lake typical of the Great Basin. The samples were placed in circular flat bottomed pans 4½ inches deep and 12 inches in diameter, filled to the same depth. The pans were left open at the top, immersed for 4 inches of their depth in an electrically heated air bath and placed in a room free from drafts. Constant temperature was maintained in the air bath by means of a thermostat. The successive depth of water in the pans was calculated from the observed weight and specific gravity and known dimensions of the pans. The results of the test are shown in Figure 1. From that diagram it appears that the rate of evaporation from Owens Lake brine decreases as the specific gravity increases, it being about 27 per cent less than distilled water when crusting commenced, at a specific gravity of 1.275. After the crust began to form it was broken up at intervals and the rate was observed to be 75 per cent less than distilled water for a specific gravity of 1.32 and continued to increase with increasing densities. As a practical check on the curve there is available for the period January 1, 1908, to December 31, 1914, detailed data of inflow into Owens Lake and fluctuations of lake level. The average area of exposed water surface during this period was 58,173 acres and the specific gravity of lake water 1.11. The average annual depth of evaporation from the lake surface as determined from the data was 60.8 inches. The observed rate from fresh water at Owens River near Independence for the three years 1908 to 1911 as observed in a floating submerged pan was 67 inches annually. Reducing this by 10 per cent as indicated by the curve there results 60.3 inches for the annual loss from Owens Lake as compared with 60.8 inches as determined above. It is believe that this curve is generally applicable to bodies of highly mineralized water. It should be noted, however, that crusting will probably begin at slightly differing specific gravities, depending upon the chemical composition of the salts in solution.

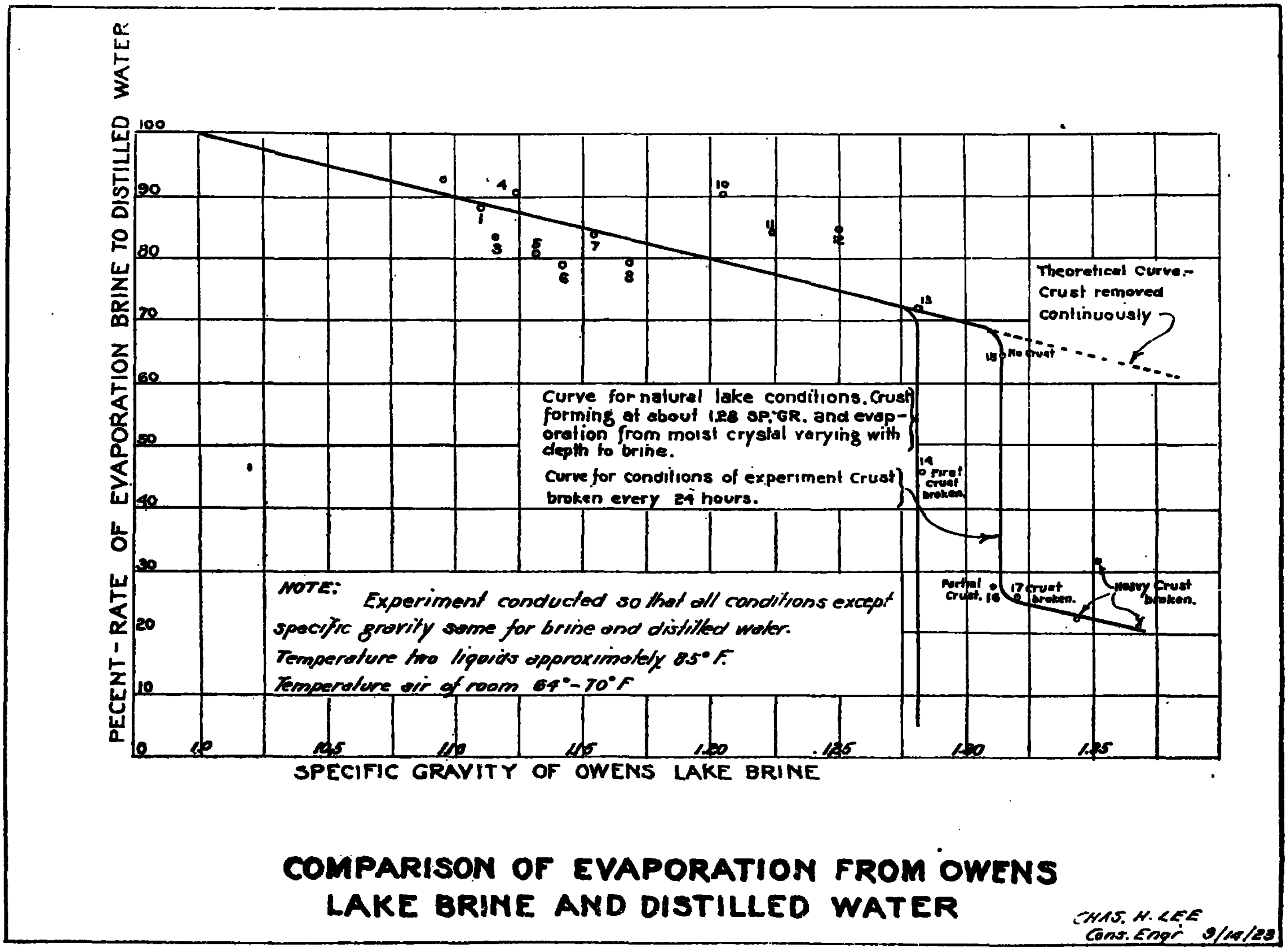

FIG. 1—Comparison of evaporation from Owens Lake brine and distilled water

The practical application of hydrology to problems in western North America involves not only a knowledge of evaporation from a free water surface, but also from capillary films surrounding soil grains, crystals of precipitated alkali salts and snow. The evaporation from moist soil also has three cases which may greatly modify it, viz, transpiration losses from vegetation, surface crusting due to salts precipitated from evaporating soil moisture, and presence of clay in a highly colloidal state resulting from concentrated alkali solutions.

In the hope of stimulating investigation the author outlines the following problems, (1) the evaporation from capillary films; (2) moist soils; (3) the transpiration from vegetation; and (4) the evaporation from moist crystal deposits and from snow.

His conclusion follows:

In conclusion it is desired to emphasize two points, first, that the study of evaporation should not be confined to free-water surfaces but should be extended to capillary films surrounding soil grains, crystals of alkali salts and snow and in connection with soils should include the process of transpiration; second, that there is greatly needed a study of methods of measuring the various types of evaporation and an authoritative adoption of standards. The subject of evaporation is important not alone in western America but throughout all arid and semi arid regions of the world.

In view of the progress already made in the study of evaporation in its various phases in western America, it is suggested as appropriate and opportune at this time that a committee of the American Meteorological Society be appointed for the purpose of outlining needed investigation and selecting standard methods of observation.

THE COURSE TRAVELED BY WIND AND WEATHER IN A DAY—AN AID IN WEATHER FORECASTING[1]

By Dr. C. Kassner

[Berlin, Germany]

It is known from long experience that not only laymen but also many meteorologists overestimate the velocity of a weather change. In this I do not refer to the fact, for example, that after a rather long period of cold an approaching low-pressure area with warm winds on the front side does not bring a reversal of weather conditions by any means so rapidly as is expected by many who eagerly wish for it. This physical advance will not be considered here, but only the advance of the air masses with wind and weather, or, in other words, the problem of the location after 24 hours of a wind or a low pressure area that is advancing with a given velocity per second or per hour. In this it must naturally be assumed for the sake of simplicity that the path is a straight line. It will, indeed, be a matter of estimation only. But even so it appears to me that the solution of the problem will be rather useful, especially in bringing into lay circles clearer ideas as to the velocity of weather changes.

I proceed with a velocity of 10 meters per second—36 kilometers per hour, 864 kilometers per day of 24 hours. I have chosen this velocity (1) since from this estimation can be made readily for any other velocity, and (2) since this is on an average the velocity with which American depressions move across the Atlantic Ocean toward Europe. Much difficulty was encountered in the selection of the chart to include North America, the Atlantic Ocean, and Europe. I finally decided upon the Mercator projection. Further, in order to meet the requirements for Europe and America I chose two systems of isochronous lines; one with initial position in America, the other with corresponding position in Europe, namely, the meridians of 60° and 0° west longitude, which are marked 0–0. The European system has continuous lines, the American system broken lines. The numbers 1, 2, 3, etc., denote days, that is an air particle or a chosen part of a low pressure area after a day or 24 hours of advance along a parallel, thus from west to east or from east to west, will reach the isochron 1, and in two days the isochron 2, and so on. Of course the beginning may be made with any other isochron. The chosen system of drawing of lines and the different figures do not admit of exchange. We must always take only the lines of one system or those of the other, and not both indiscriminately.

[1] Translated from the German by C. Le Roy Meisinger.

The fact that the isochrons diverge toward the north is naturally the result of curvature of the earth and the projection of a sphere upon a plane surface.[2]

The following small tables may be of value in using the chart:

Velocity equivalents

Meters per second	Kilometers per hour	Kilometers per day
20	72	1,728
15	54	1,296
10	36	864
5	18	432
2.5	9	216

Distance traveled in 1 day in degrees of longitude

Latitude	Length (degrees longitude in kilometers)	Velocity in m. p. s.				
		20	15	10	5	2.5
°		°	°	°	°	°
70	38.18	45.3	33.9	22.6	11.3	5.7
60	55.79	31.0	23.2	15.5	7.7	3.9
50	71.69	24.1	18.1	12.1	6.0	3.0
40	85.38	20.2	15.2	10.1	5.1	2.5
30	96.47	17.9	13.4	9.0	4.5	2.2
20	104.63	16.5	12.4	8.3	4.1	2.1
10	109.63	15.8	11.8	7.9	4.0	2.0
0	111.31	15.5	11.6	7.8	3.9	1.9

Hence at latitude 70° a wind of 20 m. p. s. will traverse an entire quadrant in two days, but at the Equator it will traverse only one-third of that distance; at latitude 70° it would pass along the entire coast of North America, while at the Equator is would just cross South America. It is always useful in making such matters clear to give some geographical measurements, for example:

	Kilometers
Boston–Detroit	1,000
Buffalo–Key West	2,000
Chicago–Salt Lake City	2,000
Baltimore–Salt Lake City	3,000

Up to this point there has been considered only the movement in west-east or east-west direction; the charts contain, however, also the isochrons for the directions north-south and south-north, the broken lines parallel to the parallel circles. Here the velocity of 10 m. p. s. is taken as the basis and the lines are drawn to north and to south of the parallel of 50° N. latitude. In order to avoid confusing figures these lines are not numbered, and to me it appears unnecessary since there are only six to be considered.

If we wish to find with the aid of the chart after what length of time, on an average, a low pressure area whose center lies off Cape Hatteras will arrive on the European coast, we note that the continuous line 8 runs off Hatteras and so the minimum (pressure) is to be expected in the English Channel in about 8 days. An excellent example of this is the cyclone of August, 1873 (Hann, Lehrbuch der Meteorologie, 3 Aufl. S. 610, fig. 80), which lay off Hatteras on the 23d and off Ireland on the 31st; just 8 days were necessary for crossing the ocean. The storm of August 24–September 3, 1883, also shown in the figure mentioned, had a velocity twice

[2] Supervising Forecaster Bowie confirms the fact illustrated by Doctor Kassner's chart, viz, that the northern ends of the major axes of HIGHS and LOWS make greater distance in longitude than their southern ends, so that these major axes incline more and more from north-south to an east-west direction. This action is especially noticeable when troughs of low pressure and ridges of high pressure are about to pass eastward onto the Atlantic from the North American Continent. It is a phenomenon that all students of the weather chart should keep in mind.—*Editor*.